Claims

[c1] A method of determining a pumping schedule adapted for fracturing a formation penetrated by a wellbore, comprising the steps of:

defining a selected pumping schedule to include an initial portion and a remaining portion;

interrogating a pump data model in response to at least one of said initial portion and said remaining portion thereby generating a return on investment;

deciding if said return on investment is a particular return on investment; and

determining said pumping schedule to be said initial portion and said remaining portion of said selected pumping schedule when said return on investment is said particular return on investment.

[c2] A method of determining a pumping schedule corresponding to a particular return on investment for a particular wellbore, the pumping schedule including an initial pumping schedule and a remaining pumping schedule, comprising the steps of:

(a) fracturing one or more perforations in a formation penetrated by the particular wellbore, thereby creating

one or more fractures in said formation, in accordance with said initial pumping schedule;

(b) analyzing a set of fracture characteristics associated with said one or more fractures in response to the fracturing step;

(c) interrogating a pump data model in accordance with said remaining pumping schedule; and

(d) determining a particular return on investment for said particular wellbore in response to the interrogating step, said pumping schedule corresponding to said particular return on investment for said particular wellbore being determined when said pump data model is interrogated in response to said remaining pumping schedule.

[c3] The method of claim 2, wherein the analyzing step (b) for analyzing a set of fracture characteristics associated with said one or more fractures in response to the fracturing step comprises the steps of:

(b1) analyzing a set of fracture characteristics associated with said one or more fractures in response to the fracturing step; and

(b2) calibrating a pump data model in response to the analyzing step (b1) thereby generating a calibrated pump data model.

[c4] The method of claim 3, wherein the interrogating step (c) for interrogating a pump data model in accordance with

said remaining pumping schedule comprises the steps of:

(c1) interrogating said calibrated pump data model in response to said remaining pumping schedule.

[c5] The method of claim 4, wherein the determining step (d) for determining a particular return on investment for said particular wellbore in response to the interrogating step comprises the step of:

(d1) determining a particular return on investment for said particular wellbore in response to the step of interrogating said calibrated pump data model in response to said remaining pumping schedule, said pumping schedule corresponding to said particular return on investment for said particular wellbore being determined when said calibrated pump data model is interrogated in response to said remaining pumping schedule.

[c6] The method of claim 3, wherein the interrogating step (c) for interrogating a pump data model in accordance with said remaining pumping schedule comprises the steps of:

(c1) changing a proportion of said frac fluid and said proppant in said remaining pumping schedule thereby generating a new remaining pumping schedule; and

(c2) interrogating said calibrated pump data model in response to said new remaining pumping schedule.

[c7] The method of claim 6, wherein the determining step (d) for determining a particular return on investment for said particular wellbore in response to the interrogating step comprises the step of:

(d1) determining a particular return on investment for said particular wellbore in response to the step of interrogating said calibrated pump data model in response to said new remaining pumping schedule, said pumping schedule corresponding to said particular return on investment for said particular wellbore being determined when said calibrated pump data model is interrogated in response to said new remaining pumping schedule.

[c8] A method of determining a return on investment associated with a particular wellbore before completing a fracturing of a formation penetrated by the wellbore, said formation being fractured in response to a particular pumping schedule, a pump data model generating one or more values indicative of said return on investment when interrogated by at least a portion of said pumping schedule, said method comprising the steps of:

(a) before completing said fracturing of said formation, interrogating said pump data model in response to said at least a portion of said pumping schedule; and

(b) generating one or more values indicative of said return on investment in response to the interrogating step.

[c9] The method of claim 8, wherein the interrogating step (a) further comprises the steps of:

calibrating said pump data model; and

before completing said fracturing of said formation, interrogating the calibrated pump data model in response to said at least a portion of said pumping schedule.

[c10] A method of determining a pumping schedule adapted for fracturing a formation penetrated by a wellbore, said pumping schedule including an initial pumping schedule and a remaining pumping schedule, comprising the steps of:

(a) fracturing said formation penetrated by said wellbore in accordance with said initial pumping schedule thereby generating fractures in said formation;

(b) interrogating a pump data model in response to said remaining pumping schedule thereby generating a return on investment;

(c) in response to the interrogating step, deciding whether said return on investment is a particular return on investment; and

(d) in response to the deciding step (c), determining said pumping schedule to be said initial pumping schedule and said remaining pumping schedule when said return on investment is said particular return on investment.

[c11]   The method of claim 10, wherein the fracturing step (a)
        for fracturing said formation penetrated by said wellbore
        in accordance with said initial pumping schedule com-
        prises the steps of:
        (a1) fracturing said formation penetrated by said well-
        bore in accordance with said initial pumping schedule;
        (a2) generating a set of fracture characteristics in re-
        sponse to the fracturing step (a1);
        (a3) analyzing said set of fracture characteristics; and
        (a4) calibrating a pump data model in response to the
        analyzing step (a3) thereby generating a calibrated pump
        data model.

[c12]   The method of claim 11, wherein the interrogating step
        (b) for interrogating a pump data model comprises the
        step of:
        (b1) interrogating said calibrated pump data model in
        response to said remaining pumping schedule thereby
        generating a return on investment.

[c13]   The method of claim 11, wherein the interrogating step
        (b) for interrogating a pump data model comprises the
        step of:
        (b1) changing a proportion of a frac fluid and a proppant
        in said remaining pumping schedule thereby generating
        a new remaining pumping schedule; and
        (b2) interrogating said calibrated pump data model in

response to said new remaining pumping schedule thereby generating a return on investment.

[c14] The method of claim 11, wherein generating step (a2) for generating a set of fracture characteristics comprises the steps of:

interrogating the pump data model in response to the initial pumping schedule thereby generating a set of pump data model fracture characteristics,

generating a set of tiltmeter data fracture characteristics on the condition that a tiltmeter data sensor is located adjacent the fractures, and

generating a set of micro-seismic data fracture characteristics on the condition that a micro-seismic data sensor is located adjacent the fractures.

[c15] The method of step 14, wherein the analyzing step (a3) for analyzing said set of fracture characteristics comprises the step of:

determining whether said set of pump data model fracture characteristics substantially matches said set of tiltmeter data fracture characteristics and said set of micro-seismic data fracture characteristics.

[c16] The method of claim 15, wherein said pump data model is calibrated thereby generating said calibrated pump data model in response to the analyzing step (a3) when

said set of pump data model fracture characteristics substantially matches said set of tiltmeter data fracture characteristics and said set of micro–seismic data fracture characteristics.

[c17] The method of claim 16, wherein the interrogating step (b) for interrogating a pump data model comprises the step of:

(b1) interrogating said calibrated pump data model in response to said remaining pumping schedule thereby generating a return on investment.

[c18] The method of claim 16, wherein the interrogating step (b) for interrogating a pump data model comprises the step of:

(b1) changing a proportion of a frac fluid and a proppant in said remaining pumping schedule thereby generating a new remaining pumping schedule; and

(b2) interrogating said calibrated pump data model in response to said new remaining pumping schedule thereby generating a return on investment.